Wydawnictwo UR 2022
ISSN 2544-1361 (online)
doi: 10.15584/ejcem.2022.2.6

http://www.ejcem.ur.edu.pl
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2022; 20 (2): 176–184

ORIGINAL PAPER

Zeynep Aközlü [1], Özlem Öztürk Şahin [2]

The effects of mother's voice and white noise on APGAR scores of newborns and attachment processes – a randomized controlled trial

[1] Medical Services and Techniques Department, Vocational School, Maltepe University, Istanbul, Turkey
[2] Department of Pediatric Nursing, Faculty of Health Sciences, Karabük University, Karabük, Turkey

ABSTRACT

Introduction and aim. The present study aims to determine the effects of mother's voice and white noise on newborns' APGAR scores and attachment processes.

Material and methods. The current study was a randomized controlled trial and concluded with 87 newborns and their mothers who had given elective cesarean section (mother voice=29; white noise=28; and control group=30). The mother voice and white noise groups were exposed to recordings, and the broadcast continued for five minutes. The APGAR scores and attachment indicators of newborns (eye contact, rooting, and latch-on) of all groups were examined by the Newborn Attachment Indicators Observation Form.

Results. The 1st and 5th minute APGAR scores in control group were lower than mother voice (1st p=0.05; 5th p=0.001) and white noise (1st p=0.015; 5th p=0.002) groups. The rooting ratio was higher in mother voice and white noise than in the control group (p=0.004). The newborns in the control group had lower latching on rates than mother voice and white noise (p=0.002) groups. Both mother voice and white noise positively affected APGAR scores, rooting, and latching. However, only mother voice had a positive effect on all attachment indicators.

Conclusion. Mother voice and white noise listened to by the newborns born with a cesarean section right after birth in their early-period care positively affect APGAR scores; furthermore, mother voice positively affects attachment indicators as first successful sucking time and eye-to-eye contact.

Keywords. APGAR score, attachment, breastfeeding, newborn, white noise

Introduction

When newborns breathe for the first time, various physiological changes commence adapting to the world outside the uterus.[1] The first few minutes after birth are significant in the adaptation processes of mothers and newborns and their relationship with each other.[2] Initiation of mutual gaze, skin-to-skin contact, and breastfeeding in the first minutes after birth is crucial for the cardiopulmonary stabilization of the infant and initiation of mother-infant bonding.[3] Early initiation of the mother-infant relationship facilitates the newborn's adaptation to extrauterine life and accelerates the attachment process.[1] The first 60-90 minutes after birth is suitable for initiating mother-infant interaction.[4] However, the increase in births given with cesarean section (CS) negatively affects mother-infant attachment.[5] The negative effect is particularly noticeable in cesarean deliveries performed under general anesthesia.[6]

Corresponding author: Zeynep Aközlü, e-mail: zeynepakozlu@maltepe.edu.tr

Received: 4.03.2022 / Revised: 18.03.2022 / Accepted: 20.03.2022 / Published: 30.06.2022

Aközlü Z, Şahin ÖÖ. *The effects of mother's voice and white noise on APGAR scores of newborns and attachment processes – a randomized controlled trial.* Eur J Clin Exp Med. 2022;20(2):176–184. doi: 10.15584/ejcem.2022.2.6.

Attachment is defined as attaching in two-way between the baby and the parent; on the contrary, bonding is a one-way emotional bonding of the parents to the baby; it is expected in the first days after birth.[7] In a positive mother-infant interaction, a mother makes eye-to-eye contact with the baby, touches, talks, and smiles. She further wants to breastfeed the baby and holds the baby in her arms except for caring. The baby also responds to the mother by rooting, latch-on, sucking, swallowing, and eye contact.[1]

The first acoustic stimuli for the fetus to be exposed before birth are the mother's voice and the sounds of the mother's heartbeat.[8] In the postpartum period, the mother's voice (MV) is an exclusive line of communication between the mother and the infant, and it is the primary auditory stimulus for newborns.[9] Moreover, in preterm newborns, MV has a positive effect on decreasing apnea and bradycardia attack frequencies, improving sleep quality, stabilizing vital signs, and promoting early discharge from neonatal intensive care units.[10]

White noise (WN) consists of a mixture of various frequencies coming from the environment and is a constant, monotonous noise that covers all disruptive noises coming from the external environment.[11] It is created in a sound laboratory environment by digitally mixing equal amounts of sounds of different frequencies and reducing the unpleasant frequencies in these sounds.[12] Because of its monotonous humming characteristics, WN resembles the noises during fetal stages.[8] The fetus is affected by the mother's heartbeat while in intrauterine life. Hearing these familiar sounds and rhythms once more in the postpartum period has a calming effect on the newborn.[12]

In the literature, postpartum MV is generally used for cardiopulmonary stabilization of preterm newborns.[13–15] WN is mainly used during painful procedures applied to term newborns.[12,16] However, no prior study is found about the effects MV or WN has on newborns' APGAR scores and attachment indicators.

Aim

The current study aims to establish the effects of MV and WN on the APGAR scores and attachment processes of newborns born with elective CS.

The hypotheses of the study were:

H_1. Mother's voice introduced right after birth positively affects APGAR scores.

H_2. White noise introduced right after birth has a positive effect on APGAR scores.

H_3. Mother's voice introduced right after birth positively affects attachment processes.

H_4. White noise introduced right after birth has a positive effect on attachment processes.

Material and methods

The setting, sample size, and randomization

This randomized controlled trial population consisted of women who had given elective CS and their newborns residing at a research and training hospital in Turkey between January and June 2017. In the study, primary assessments of newborns were made in the operating room, where the CS procedure takes place in an adjacent room located inside the operating room. In the hospital where this study took place, the room used for newborn care was located inside the operating room, and it was a 12 square-meter room dedicated to this purpose only. Having a dedicated newborn care room was significant in choosing this hospital for the study.

Literature was taken as a reference to determine the sample size.[17] Additionally, posthoc analysis was used to confirm whether or not a sufficient sample size was reached at the end of the study with G*Power 3.1.9.2 (Heinrich Heine University Düsseldorf, Germany). As a result of the analysis, the effect size was 0.4359, and the power calculated by posthoc analysis as a result of the study conducted with 87 people was 0.95. For posthoc analysis, the minimum power value to be obtained is 0.67. In this case, the power of the study was on an acceptable level.

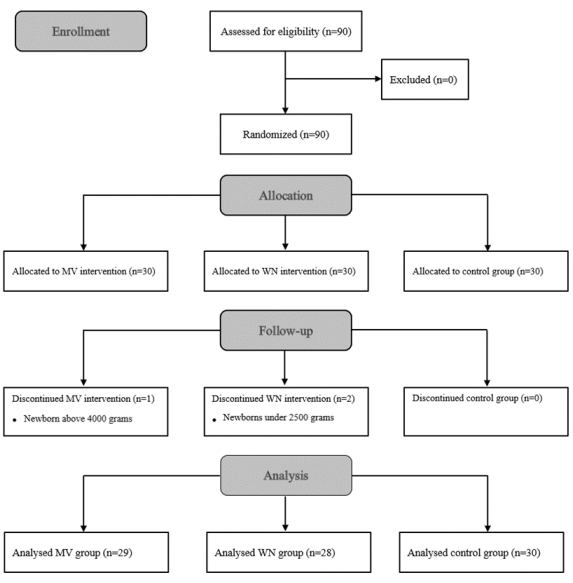

Fig. 1. CONSORT flow diagram of study

Since CS planned the deliveries, the hospitalization of the pregnant women took place the day before the surgery. The mothers were separated into groups using simple randomization (90 sealed envelopes (MV: 30, WN: 30, CG: 30) when they were hospitalized. After the randomization, the Mother Information Form (MIF) was applied to the 90 mothers by the implementer researcher (IR). The inclusion criteria for mothers were determined as having a healthy, single pregnancy, not

taking any medication during pregnancy, not having a background of auditory or speech impediments, having a CS under general anesthesia, and voluntarily taking part in the current study. The inclusion criteria for newborns were obtained as being born at term, being single live birth, having a birth weight between 2500 and 4000 grams, and not having any congenital anomalies. Exclusion criteria were intraoperative complications for mothers and the need for postnatal resuscitation for newborns. The current study was concluded with 87 newborns (MV: 29, WN: 28, CG: 30) in accounts of a newborn in the MV having a birth weight over 4000 grams and two newborns in the WN having a birth weight under 2500 grams (Fig. 1).

Tools

Mother information form (MIF)

The researchers prepared the form, and included questions on the mother's sociodemographic characteristics, number of pregnancies, and prenatal care status. The form included questions on stroking the belly, talking to the fetus, and whether or not the pregnancy was planned, which have evidence of affecting attachment in the literature.[18,19] It also questioned whether or not there was any hearing/speech problem in the mother and whether she had experienced any health problem during her pregnancy.[20] The IR used MIF in the pre-intervention phase of the study.

Newborn information form (NIF)

The researchers prepared the form, and it contained questions on the date-hour of birth and gestational week of the newborn, sex, postpartum anthropometric measurements and, 1st and 5th minute APGAR scores.[21] The IR used NIF in the intervention phase of the study.

Newborn attachment indicators observation form (NAIOF)

The form was prepared by the researchers and used by the OR in the post-intervention phase of the study. Various attachment scales in the literature may be applied before or after delivery.[22] However, these scales investigate the bonding of the mother to the newborn. This form is on the indicators of newborns in the postpartum period as crying, making eye contact, rooting, latch-on breast, starting active sucking, and on which minute after delivery this indicator is displayed.[23,24] The NAIOF recorded the newborns' crying state and at what stages of their interaction with their mother they stopped crying.

Intervention phases

Pre-intervention

The IR conducted face-to-face interviews with the mothers one night before the procedure. MIF was filled for 90 participants who had voluntarily accepted to partake in the current study.

Mother voice group: First, it was explained to each mother in the MV group that the noise they would be broadcasting to their infants would not harm them, and the noise levels would be kept in check with a decibel meter (BENETECH GM1351, Shenzhen, China). Instructions on using the voice recorder (SONY ICD-PX440, Tokyo, Japan) were given by the IR to the mothers in the MV group. A handheld voice recorder, which works with an external battery and can record for up to 72 hours without interruptions, recorded the mothers' voices. A 5-minute improvisational monologue was demanded from the mothers, consisting of the first words they wanted their infants to hear. For the mothers to express their emotions freely, they were left alone in the room. The voice recordings were transferred to the computer (LENOVO G510, Peking, China). Every mother should have her baby listen to the recording. The mothers listened to the audio recordings before the surgery and confirmed to avoid accidents with these recordings. Copies were made onto a compact disc for the mothers who preferred to keep these recordings as a memento.

White noise group: A 5-minute recording prepared by a producer in a digital sound laboratory was used as the WN demo. For the production of the WN, reFX Nexus VSTi v2.4, a sound synthesizer in the FL Studio Producer Edition V12.0.1 Digital Audio Workstation software (Gent, Belgium), was used. By utilizing the White Noise Cut-off filter included in the software, the sharpness of the noise was reduced to -75; thus, it was attempted to acquire a sound similar to womb sounds. Studies on the effects of white noise in the scientific literature were examined to establish that these recordings had melodic tones in them.[11,12,25] The sound recording used in this study was produced exclusively to eliminate melodic tones, acquiring a sound much similar to the womb sounds and not have any problems over royalties. A demo recording of white noise was played (with PHILIPS SPA2201, Amsterdam, Netherlands) to the mothers in the WN group. It was notified that the sound is very similar to the baby's sounds in the womb, and WN they would be broadcasting to their infants would not harm them, and the noise levels would be kept in check with a decibel meter (BENETECH GM1351, Shenzhen, China). LENOVO G510 laptop was used to store the records and broadcast the WN. All newborns in the WN group listened to the same demo. Copies were made onto a compact disc for the mothers who preferred to keep this demo as a memento.

Control group: No specific preliminary preparations were made for the mothers in CG.

All mothers were instructed not to tell the OR which sounds their newborns listened to after they were taken

to the room. The OR was blind to the sound listened to by the newborns while filling out the NAIOF.

When the mothers were taken into the operating room, the preparation of the neonatal care room was achieved by the neonatal nurse accompanied by the IR. Before each birth, equipment and the room cleanliness were checked for malfunctions, test measurements were taken with the decibel meter, and the radiant heater that was used was set constant at 26°C.

Intervention

The newborns were taken to the care room by the neonatal nurse immediately after their birth. The CS in this study took place under general anesthesia; the newborn was brought to the care room immediately after birth without skin-to-skin contact with its mother. As the neonatal care room was next to the operating room where the deliveries took place, it took 3-5 seconds on average to bring the newborns to the neonatal care room. The doors were kept closed to block any noise that could infiltrate the room. Only the neonatal nurse and the IR were present during the procedures in the room. The decibel meter was placed 5 cm above their top lines to assess the noise levels reaching the newborns' ears. Battery operated, handheld decibel meter was used to measure noises between 30-130 dB with a precision of ± 1.5 dB and can take up to 2 measurements every second (BENETECH GM1351, Shenzhen, China).

The newborns in the intervention groups (MV, WN) were exposed to the recordings as soon as they arrived at the room, and the voice broadcast continued for five minutes. For the broadcastings of the sounds, PHILIPS SPA2201 stereo speakers, with analog control for the noise levels and a power indicator, were used. Following the suggestions made by the AAP on the maximum noise levels suitable for newborns, the noise level was limited at 45 dB.[26] The newborns in CG did not receive any auditory interventions and were only exposed to background noise.

During the listening of the sounds to all groups, the newborns' ankle IDs were worn by the newborn nurse; umbilical care was performed, anthropometric measurements were taken, Hepatitis B vaccines and vitamin K were administered (A calibrated SECA354 digital baby scale with an accuracy of ± 5-10 grams was used for weighing newborns. An inflexible tape measure with 0.1 cm intervals was used to measure the head circumference and height of the newborns). At this stage, the same researcher always made the 1st and the 5th minute APGAR score measurements (IR). In contrast, the routine newborn care procedures were always carried out by the same neonatal nurse working at the institution who was not among the researchers of this study. The researcher only kept time and scored the APGAR. The neonatal nurse constantly measures the APGAR score to record it on the hospital's forms. The neonatal nurse and IR wrote down each newborn's APGAR score on separate papers and then showed them simultaneously to avoid bias in APGAR score measurement. All responses showed consistency. Calibrated NELLCOR N560 console type pulse oximeter was utilized to establish the heart rates of the neonates to determine their APGAR scores. The total APGAR scores and information about the newborns were recorded on the NIF.

Post-intervention

As the hospital where the study was carried out is a baby-friendly hospital, although deliveries occur by CS, it is ensured that the newborns and mothers meet within the first 30 minutes. When the mothers are taken from the operating room to the recovery room, they are monitored for 15 minutes and then taken to their rooms. It takes 10 minutes on average to take the mother to her bed in her room and apply her post-op care. All mothers had skin-to-skin contact with their babies within 30 minutes. At this moment, in the neonatal care room, the first examination of the newborn is made by a pediatric doctor. As soon as the mothers left the recovery room and were brought into the private rooms, the OR started applying the NAIOF. The mothers' postpartum readiness to receive their newborns was assessed by obstetric nurses, such as not having pains and stable conditions. According to the Delivery Room Management Guide of the Turkish Neonatal Society, only newborns with the 1st and 5th minute APGAR scores of 7-10 are those that do not require further monitoring and can be given to their mothers.[27] Obstetric nurses informed the neonatal nurse that the mother was ready to receive the newborn, and the newborns were then carted into their mothers' rooms by the neonatal nurse in a wheeled baby cart. The newborns were given to their mothers in a cradling position. The mothers were encouraged about the initialization of breastfeeding to start the attachment. Neonatal nurses carried out these procedures, whereas the OR continued to observe. The time elapsed for breastfeeding to be initiated by the newborns was calculated following the scientific literature. Effective breastfeeding was described as one where a mother can hear her infant swallow and feel her infant's temporalis muscle movements.[28] While the temporalis muscle movements of the newborns were being observed, the mothers were instructed to alert the OR when they heard their infants swallow. Thus, the exact time that elapsed for breastfeeding to begin was recorded in a controlled manner. The mothers were also instructed to alert the OR when they made eye contact with their infants. As newborns' initial period of reactivity lasts for about 60 minutes on average, the OR completed the observations and left the room on the 90th minute.[29]

Data analysis

The IBM SPSS Statistics 22 (IBM Corp, Armonk, New York, USA) was used to evaluate the data. The level of statistical significance was set at $p<0.05$. The descriptive results are presented with the person count, percentage, standard deviation, and mean values. Comparisons of the discrete variables were carried out with Chi-squared Test, and the normality assessments of the distribution for the continuous variables were conducted using Shapiro-Wilk Test. In the comparison between more than two groups, when the distribution of the variables was normal, One-Way ANOVA, when the distribution was abnormal, Kruskal-Wallis H test was utilized. In order to assess the normality of the dependent variable distributions (APGAR score), Kolmogorov-Smirnov and Shapiro Wilk tests were utilized. The variable was established to show a normal distribution. A newborn in the MV group and two newborns in the WN group were excluded from data analysis because of incomplete and missing data.

Results

A total of 87 newborns and mothers who met the criteria participated in the current study (MV: 29, WN: 28, CG: 30). There was no significant difference among the three groups when the mothers and their newborns in the study were analyzed based on their descriptive characteristics (Table 1).

When the 1st minute APGAR scores of the newborns were compared to each other, the difference between the mean scores was statistically significant (p=0.009). The scores in CG were lower than those in the MV (Z=-2.836; p=0.05) and WN groups (Z=-2.432; p=0.015). In comparing the 5th minute APGAR scores of the newborns, the difference between the mean scores of the groups was statistically significant (p=0.001). The scores in CG were lower than those in the MV (Z=-3.363; p=0.001) and WN groups (Z=-3.080; p=0.002). The 1st and 5th minute APGAR scores of the MV group were higher than those in the WN group. However, the difference was not statistically significant in both cases (p>0.05) (Table 2). These findings support the current study's first and second hypotheses (H_1-H_2).

There was no significant difference among the groups concerning the crying status of the newborns when they were first brought into the room (p=0.442) and the crying statuses of the same newborns after they were cradled by their mothers (p=0.109). Every newborn in each group was cradled and breastfed by their mother, establishing eye contact. The rooting ratio was higher in the MV and the WN groups than the newborns in CG (p=0.004). The newborns in CG had lower latching on rates than the MV and WN groups (p=0.002) (Table 3).

In the duration of attachment indicators of the newborns' comparison, in the mean times of starting to suck and having eye contact, CG had the highest mean scores, while MV had the lowest ones. These mean scores of CG were also higher than those in WN; however, the differences were not significant in any of the three parameters (p>0.05). A statistically significant difference was determined in the elapsed mean time between the groups for the first sucking to occur in the newborns (p=0.002). CG in comparison to the MV group (Bonferroni Mean Difference (BMD)=-6.174; p=0.001) and the WN group in comparison to the MV group (BMD=-4.350; p=0.041) had higher scores. A statistically significant difference was determined between the groups when examining the elapsed meantime for eye contact between the mothers and their newborns (p=0.002). CG in comparison to the MV group (BMD=-3.440; p=0.001) and the WN

Table 1. Descriptive characteristics of newborns and mothers

Variables	CG (*n*=30) Mean ± SD n	%	MV (*n*=29) Mean ± SD n	%	WN (*n*=28) Mean ± SD n	%	Total (*N*=87) Mean ± SD n	%	*Test value*	*p*
Gestational age	38.77 ± 0.68		38.69 ± 0.71		38.86 ± 0.76		38.77 ± 0.71		0.859	0.651[b]
Height (cm)	50.3 ± 1.15		49.93 ± 1.12		49.25 ± 1.56		49.84 ± 1.38		1.804	0.17[b]
Weight (g)	3296.33 ± 346.34		3288.62 ± 301.51		3252.68 ± 366.38		3279.71 ± 346.35		0.479	0.787[b]
Head circumference (cm)	35.07 ± .58		35.59 ± 1.05		35.36 ± 0.99		35.33 ± 0.91		3.943	0.139[b]
Mothers' age	29.78 ± 5.64		29.69 ± 4.38		30.5 ± 3.83		29.98 ± 4.66		0.252	0.778[c]
Pregnancy status										
Planned	25	83.3	27	93.1	21	75	73	83.9	3.688	0.158[a]
Unplanned	5	16.7	2	6.9	7	25	14	16.1		
Sex										
Female	15	50	14	48.3	14	50	43	49.4	0.023	0.989[a]
Male	15	50	15	51.7	14	50	44	50.6		
Talking with fetus and stroking belly										
Yes	24	80	22	75.9	23	82.1	69	79.3	0.356	0.837[a]
No	6	20	7	24.1	5	17.9	18	20.7		

Abbreviations: SD – Standard deviation; a – Chi-squared test; b – Kruskal-Wallis H test; c – One-Way ANOVA test

group in comparison to the MV group (BMD=-2.384; p=0.017) had higher scores (Table 4). These findings support the third hypothesis (H_3) and reject the study's fourth hypothesis (H_4).

Discussion

In the present study, only the 1st and 5th minute APGAR scores were checked, and all the newborns had higher scores than 7. The 1st minute and the 5th minute mean APGAR scores were significantly higher with the newborns exposed to their MV or WN than the CG. There was no significant difference between them when it was checked which MV and WN had more positive effects on the APGAR scores. Although there are some studies in the literature examining the effects of MV and WN on newborns, the current study is the first to examine the effects of these two sounds on the APGAR score. Still, preterm newborns who were not exposed to their MV had significantly lower heartbeat rate than those exposed to their MV.[30] Sajjadian et al. reported in a study conducted with newborns that the ones exposed to their MV had a more stable pulse reading, respiration, and oxygen saturation than the control.[15] In these two studies, MV positively affected the APGAR parameters of pulse and respiration, which was in agreement with the present study. Further, considering that oxygen satu-

Table 2. Comparison of APGAR scores of newborns

APGAR scores	CG (*n*=30) Mean ± SD (Min-Max)	MV (*n*=29) Mean ± SD (Min-Max)	WN (*n*=28) Mean ± SD (Min-Max)	Total (*N*=87) Mean ± SD (Min-Max)	*Test value*	*p*	*difference*
1st min	7.7 ± 0.6 (7-9)	8.17 ± 0.6 (7-9)	8.14 ± 0.71 (7-9)	8 ± 0.67 (7-9)	9.355	0.009[a*]	CG < MV CG < WN
5th min	8.87 ± 0.68 (8-10)	9.48 ± 0.57 (8-10)	9.43 ± 0.57 (8-10)	9.25 ± 0.67 (8-10)	14.331	0.001[a*]	CG < MV CG < WN

Abbreviations: SD – Standard deviation; a – Kruskal-Wallis H test; * = p<0.05

Table 3. Comparison of attachment indicators of newborns

Variables	CG (*n*=30) n	%	MV (*n*=29) n	%	WN (*n*=28) n	%	Total (*N*=87) n	%	*Test value*	*p*
Crying status of newborns when they were first brought into the room										
Crying	9	30	13	44.8	9	32.1	31	35.6	1.633	0.442[a]
Not crying	21	70	16	55.2	19	67.9	56	64.4		
Crying status of newborns who continue to cry when brought to the room after cradled by their mother (*n*=31)**										
Still crying	5	55.6	2	15.4	4	44.4	11	35.5	4.431	0.109[a]
Not crying	4	44.4	11	84.6	5	55.6	20	64.5		
Rooting										
Yes	13	43.3	23	79.3	22	78.6	58	66.7	11.222	0.004[a*]
No	17	56.7	6	20.7	6	21.4	29	33.3		
Latch-on										
Yes	6	20	17	58.6	17	60.7	40	46	12.465	0.002[a*]
No	24	80	12	41.4	11	39.3	47	54		

Abbreviations: a – Chi-squared test; * = p<0.05; ** Newborns that did not cry when brought into the room were not included in the analysis

Table 4. Comparison of attachment indicator durations of newborns

Variables	CG (*n* = 30) Mean ± SD	MV (*n* = 29) Mean ± SD	WN (*n* = 28) Mean ± SD	Total (*N* = 87) Mean ± SD	*Test value*	*p*	*difference*
Elapsed time for first sucking (minute)	66.97 ± 5.95	60.79 ± 7.5	65.14 ± 6	64.32 ± 6.96	6.937	0.002[a*]	CG > MV WN > MV
Elapsed time for first eye contact with mother (minute)	79.80 ± 8.31	71.24 ± 9.65	77.25 ± 9.24	76.13 ± 9.67	12.605	0.002[b*]	CG > MV WN > MV

Abbreviations: SD – Standard deviation; a – One-Way ANOVA test; b – Kruskal Wallis test; * = p<0.05

ration is directly related to the blood circulation in the body.[31] It may be stated that MV could positively affect appearance, which is another APGAR parameter. The current study agreed with the results reported by Sajjadian et al. in this matter.[15]

In the early postpartum period, keeping the baby in the same room with the mother, skin-to-skin contact, eye contact, and breastfeeding are essential factors that lead to mother-infant attachment.[32] Nonetheless, CS is the potential for delays in establishing breastfeeding and skin-to-skin contact.[5] In a report published by WHO, it is noted that Turkey is among the first five countries where more CS is performed than normal birth all over the world.[33] In the present study, since the study was conducted was a baby-friendly hospital, skin-to-skin contact was initiated in all newborns within 30 minutes and started sucking in the first hour on average. In two other studies, breastfeeding rates in CS were significantly lower in the first 24 hours.[34,35] In the present study, breastfeeding initiation in the first 24 hours was a positive result. The early start of breastfeeding in the study in all groups may explain why the institution that carried out the study had received the Baby-Friendly Hospital Certificate from the Turkish Ministry of Health. New mothers were provided support to breastfeeding their infants in the first hour by neonatal nurses.

Breastfeeding is a parenting factor that has been associated with the attachment of the infant and the mother. There is an enduring link between breastfed babies and infant secure attachment.[36] In the present study, the newborns that listened to MV started sucking in a shorter time than the WN and CG. The result showed that MV provided to newborns with CS might positively affect breastfeeding, which was a significant parameter of the attachment process. Akca and Aytekin found the sucking success of newborns that listened to WN higher than those that did not.[25] In the current study, although higher rates of rooting and latch-on were determined in the newborns that listened to WN and MV compared to the CG, the difference between WN and CG in starting sucking was not significant.

The time to make eye contact, which is a crucial component of the attachment process, was evaluated in the study. It was observed that initiation of eye contact took more than an hour for every newborn in each group. However, making eye contact after birth was not more than 80 minutes. A study conducted with preterm newborns portrayed that eye contact behavior was rarely found since most newborns were in a sleep state that hindered their mother's ability to make eye contact.[37] Upon delivery, the newborn stays awake for approximately two hours. The eyes are wide open with usually large pupils.[38]

Moreover, the sensitive period of 60 to 90 minutes after birth may be crucial for mothers to contact their infants for infant-mother attachment to occur.[4] In the present study, the onset of eye contact in less than 90 minutes for all groups may be interpreted as a positive result for the attachment process in line with the literature. Besides, the study also has established that the exposed to MV are faster in initiating eye contact than the other two groups. Newborns who stay with their mothers and hear her voice early are more inclined to initiate eye contact. The eye contact of newborns with their mothers allows mothers to develop positive motherhood feelings and behaviors towards their newborns; hence, the mother-infant attachment process is supported.[1] Accordingly, the exposure of newborns to the MV positively affects the attachment process in the current study.

Study limitations

The current study had some limitations. The IR was not blinded when measuring the APGAR score since she had to be exposed to sounds played to newborns. Since newborns were term, the APGAR score and the newborns' responses to sounds may have been positively affected. The generalizability of the findings in this study was limited to term newborns. Further, the generalization of the study was limited because of the small sample size.

Conclusion

In line with the current study's findings, both sounds positively have affected the APGAR scores. However, when one of the sounds is more effective in increasing the APGAR scores are questioned, there is no difference between mother voice and white noise. In examining the effects mother voice and white noise played on newborns on the attachment process, positive effects of both sounds on the newborn's rooting and latch-on were found. Only mother voice positively affects attachment indicators as first successful sucking time and eye-to-eye contact. In line with these results, in countries like Turkey, where there is an increase in surgical deliveries, listening to the mother voice to the newborns immediately after CS can be used as a breastfeeding and attachment-supportive practice.

Acknowledgments

We would like to thank the producer C.A. who contributed to the preparation of the white noise demo used in the study. We would like to thank the mothers and newborns for participation in the study.

Declarations

Funding

The authors declared that this study has received no financial support or any funding.

Author contributions

Conceptualization, Z.A. and ÖÖŞ; Methodology, Z.A. and Ö.Ö.Ş.; Formal Analysis, Z.A. and Ö.Ö.Ş.; Investi-

gation, Z.A.; Resources, Z.A.; Writing – Original Draft Preparation, ZA and Ö.Ö.Ş.; Writing – Review & Editing, Z.A. and Ö.Ö.Ş.; Visualization, Z.A.; Supervision, Ö.Ö.Ş.

Conflicts of interest

The authors declare no conflict of interest.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval

The present study protocol was carried out following the Helsinki Declaration of 1975 as revised in 2008. Ethics approval for the study was taken from Bülent Ecevit University Clinical Research Ethics Committee (Protocol no: 2015-93-21/10). The clinical research ethics committee, whose permission was obtained before the study, reviewed and approved the study's design and flow charts, informed consent forms, and data collection forms. After that - with the permission of the clinical research ethics committee - permission of the intervention was obtained from the Turkish Ministry of Health, Karabük Public Hospitals Association General Secretariat (88919140-663-08-08-E.293) and Karabük University Training and Research Hospital (34771223-663.08/00480), where the research conducted. It was explained to the participants that any information would be kept confidential, would only be used for scientific purposes, and would be notified about the study results. Participants were informed that they could leave the study at any stage. Written and verbal consents were taken from the participants who had volunteered to partake in the current study.

References

1. Widström AM, Brimdyr K, Svensson K, Cadwell K, Nissen E. Skin-to-skin contact the first hour after birth, underlying implications and clinical practice. *Acta Paediatr*. 2019;108(7):1192-1204. doi:10.1111/apa.14754
2. Phuma-Ngaiyaye E, Welcome Kalembo F. Supporting mothers to bond with their newborn babies: Strategies used in a neonatal intensive care unit at a tertiary hospital in Malawi. *Int J Nurs Sci*. 2016;3(4):362-366. doi:10.1016/j.ijnss.2016.10.001
3. Zaichkin J, Fraser D. The Healthy Newborn. In: Evans RJ, Brown YM, Evans MK, eds. *Canadian Maternity, Newborn & Women's Health Nursing*. 2st ed. Lippincott Williams&Wilkins; 2014.
4. Mutlu C, Yorbik O, Tanju I, Celikel F, Sezer R. Association of prenatal, natal, and postnatal factors with maternal attachment. *Anatol J Psychiatry*. 2015;16(6):440. doi:10.5455/apd.172669
5. Cetisli NE, Arkan G, Top ED. Maternal attachment and breastfeeding behaviors according to type of delivery in the immediate postpartum period. *Rev Assoc Med Bras*. 2018;64(2):164-169. doi:10.1590/1806-9282.64.02.164
6. Sak S, Peker N, Uyanıkoğlu H, Binici O, İncebıyık A, Sak ME. Which should be performed; General or spinal anesthesia in elective cesarean section? *Zeynep Kamil Tip Bül*. 2018;49(1). doi:10.16948/zktipb.348924
7. Bowlby J. Attachment and loss: retrospect and prospect. *Am J Orthopsychiatry*. 1982;52(4):664-678. doi:10.1111/j.1939-0025.1982.tb01456.x
8. Webb AR, Heller HT, Benson CB, Lahav A. Mother's voice and heartbeat sounds elicit auditory plasticity in the human brain before full gestation. *Proc Natl Acad Sci USA*. 2015;112(10):3152-3157. doi:10.1073/pnas.1414924112
9. Persico G, Antolini L, Vergani P, Costantini W, Nardi MT, Bellotti L. Maternal singing of lullabies during pregnancy and after birth: Effects on mother–infant bonding and on newborns' behaviour. Concurrent Cohort Study. *Women Birth*. 2017;30(4):e214-e220. doi:10.1016/j.wombi.2017.01.007
10. Provenzi L, Broso S, Montirosso R. Do mothers sound good? A systematic review of the effects of maternal voice exposure on preterm infants' development. *Neurosci Biobehav Rev*. 2018;88:42-50. doi:10.1016/j.neubiorev.2018.03.009
11. Karakoç A, Türker F. Effects of white noise and holding on pain perception in newborns. *Pain Manag Nurs*. 2014;15(4):864-870. doi:10.1016/j.pmn.2014.01.002
12. Kucukoglu S, Aytekin A, Celebioglu A, Celebi A, Caner I, Maden R. Effect of white noise in relieving vaccination pain in premature infants. *Pain Manag Nurs*. 2016;17(6):392-400. doi:10.1016/j.pmn.2016.08.006
13. Filippa M, Panza C, Ferrari F, et al. Systematic review of maternal voice interventions demonstrates increased stability in preterm infants. *Acta Paediatr*. 2017;106(8):1220-1229. doi:10.1111/apa.13832
14. Lee H, White-Traut R. Physiologic responses of preterm infants to the male and female voice in the NICU. *J Pediatr Nurs*. 2014;29(1):e3-5. doi:10.1016/j.pedn.2013.04.007
15. Sajjadian N, Mohammadzadeh M, Alizadeh Taheri P, Shariat M. Positive effects of low intensity recorded maternal voice on physiologic reactions in premature infants. *Infant Behav Dev*. 2017;46:59-66. doi:10.1016/j.infbeh.2016.11.009
16. Karakoc A, Turker F. Effects of white noise and holding on pain perception in newborns. *Pain Manag Nurs*. 2014;15(4):864-870.
17. Robiquet P, Zamiara PE, Rakza T, et al. Observation of skin-to-skin contact and analysis of factors linked to failure to breastfeed within 2 hours after birth. *Breastfeed Med*. 2016;11(3):126-132. doi:10.1089/bfm.2015.0160
18. Maddahi MS, Dolatian M, Khoramabadi M, Talebi A. Correlation of maternal-fetal attachment and health practices during pregnancy with neonatal outcomes. *Electron Physician*. 2016;8(7):2639-2644. doi:10.19082/2639
19. Nishikawa M, Sakakibara H. Effect of nursing intervention program using abdominal palpation of Leopold's

maneuvers on maternal-fetal attachment. *Reprod Health*. 2013;10(1):12. doi:10.1186/1742-4755-10-12

20. Korver AMH, Smith RJH, Van Camp G, et al. Congenital hearing loss. *Nat Rev Dis Primer*. 2017;3. doi:10.1038/nrdp.2016.94
21. Apgar V. A proposal for a new method of evaluation of the newborn infant. *Anesth Analg*. 1953;32(4):250-259. doi:10.1213/ANE.0b013e31829bdc5c
22. Perrelli JGA, Zambaldi CF, Cantilino A, Sougey EB. Mother-child bonding assessment tools. *Rev Paul Pediatr*. 2014;32(3):257-265. doi:10.1590/0103-0582201432318
23. Als H. The Newborn Communicates. *J Commun*. 1977;27(2):66-73. doi:10.1111/j.1460-2466.1977.tb01828.x
24. Essa RM, Abdel Aziz Ismail NI. Effect of early maternal/newborn skin-to-skin contact after birth on the duration of third stage of labor and initiation of breastfeeding. *J Nurs Educ Pract*. 2015;5(4):98. doi:10.5430/jnep.v5n4p98
25. Akca K, Aytekin A. Effect of soothing noise on sucking success of newborns. *Breastfeed Med Off J Acad Breastfeed Med*. 2014;9(10):538-542. doi:10.1089/bfm.2014.0131
26. Parra J, de Suremain A, Berne Audeoud F, Ego A, Debillon T. Sound levels in a neonatal intensive care unit significantly exceeded recommendations, especially inside incubators. *Acta Paediatr*. 2017;106(12):1909-1914. doi:10.1111/apa.13906
27. Oygür N, Önal E, Zenciroğlu A. *Delivery Room Management Guide*. Turkish Neonatal Society; 2016. http://neonatology.org.tr/wp-content/uploads/2016/12/dogum_odasi_yonetimi.pdf Accessed: 2021-01-21
28. França EC, Sousa CB, Aragão LC, Costa LR. Electromyographic analysis of masseter muscle in newborns during suction in breast, bottle or cup feeding. *BMC Pregnancy Childbirth*. 2014;14(1):154. doi:10.1186/1471-2393-14-154
29. Korotchikova I, Stevenson NJ, Livingstone V, Ryan CA, Boylan GB. Sleep–wake cycle of the healthy term newborn infant in the immediate postnatal period. *Clin Neurophysiol*. 2016;127(4):2095-2101. doi:10.1016/j.clinph.2015.12.015
30. Filippa M, Devouche E, Arioni C, Imberty M, Gratier M. Live maternal speech and singing have beneficial effects on hospitalized preterm infants. *Acta Paediatr*. 2013;102(10):1017-1020. doi:10.1111/apa.12356
31. Noori S, Seri I. Evidence-based versus pathophysiology--based approach to diagnosis and treatment of neonatal cardiovascular compromise. *Semin Fetal Neonatal Med*. 2015;20(4):238-245. doi:10.1016/j.siny.2015.03.005
32. Kuguoglu S, Yildiz H, Kurtuncu Tanir M, Demirbag BC. Breastfeeding after a cesarean delivery. In: Salim R, ed. *Cesarean Delivery*. BoD – Books on Demand; 2012:121-160.
33. WHO. Caesarean section rates continue to rise, amid growing inequalities in access. World Health Organization. https://www.who.int/news/item/16-06-2021-caesarean-section-rates-continue-to-rise-amid-growing-inequalities-in-access-who. Published 2021. Accessed June 19, 2021.
34. Alus Tokat M, Serçekuş P, Yenal K, Okumuş H. Early postpartum breast-feeding outcomes and breast-feeding self--efficacy in Turkish mothers undergoing vaginal birth or cesarean birth with different types of anesthesia. *Int J Nurs Knowl*. 2015;26(2):73-79. doi:10.1111/2047-3095.12037
35. Hobbs AJ, Mannion CA, McDonald SW, Brockway M, Tough SC. The impact of caesarean section on breastfeeding initiation, duration and difficulties in the first four months postpartum. *BMC Pregnancy Childbirth*. 2016;16(1):90. doi:10.1186/s12884-016-0876-1
36. Gibbs BG, Forste R, Lybbert E. Breastfeeding, parenting, and infant attachment behaviors. *Matern Child Health J*. 2018;22(4):579-588. doi:10.1007/s10995-018-2427-z
37. Tilokskulchai F, Phatthanasiriwethin S, Vichitsukon K, Serisathien Y. Attachment behaviors in mothers of premature infants: a descriptive study in Thai mothers. *J Perinat Neonatal Nurs*. 2002;16(3):69-83. doi:10.1097/00005237-200212000-00008
38. Lagercrantz H, Changeux JP. The emergence of human consciousness: From fetal to neonatal life. *Pediatr Res*. 2009;65(3):255-260. doi:10.1203/PDR.0b013e3181973b0d